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VENEER RECOVERY FROM BLACK HILLS PONDEROSA PINE

by Vern P. Yerkes
and R. O. Woodfin, Jr.

Abstract

Veneer recovered from a selected sample of 144 Black Hills ponderosa pine sawtimber trees was sufficient in both volume and grades to allow production of at least 3/8-inch C-D plywood. Proportions of C and better grades of veneer increased with veneer block diameter but decreased with tree d.b.h. and block heights in the tree. This apparently conflicting trend results from the greater number of large knots in the middle-stem blocks of larger trees. Recovery ratios increased with both tree diameter and block diameter and were higher for defective blocks than sound blocks, due to the smaller net scale for defective blocks. Nearly 45 percent of the cubic-foot volume was utilized as veneer.

Key words: Pinus ponderosa, veneer, plywood.

ACKNOWLEDGMENTS

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Veneer and plywood production facilities and crew were furnished under a cooperative agreement with the Montezuma Plywood Company, Dolores, Colorado. Without the mill's excellent cooperation, this study would not have been feasible. Garhart and Poole of Spearfish, South Dakota, contracted to haul the study logs from the Black Hills to southwestern Colorado under extremely adverse weather conditions. Their care in transporting the logs without damage and without loss of identity was important and much appreciated. The American Plywood Association's contribution of special veneer grading services provided a standard for comparing results with other studies and industry experience. Special thanks are due to their Division For Product Acceptance (DFPA) for this essential service.

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Vern P. Yerkes and R. O. Woodfin, Jr.

INTRODUCTION

Softwood plywood demand is expected to continue to rise during the 1970's and beyond (American Plywood Association 1971). At least part of the expansion of production capacity to meet this demand will likely be in areas where timber supplies are not now fully utilized, or could be more efficiently used as raw material for plywood.

To make sound decisions about locating new plywood facilities, detailed information is needed on the suitability of local timber resources for veneer production. The purpose of this study was to provide such information specifically for Black Hills ponderosa pine, Pinus ponderosa, which previously has not been used commercially for plywood.

Three previous Forest Service studies of veneer production, which included ponderosa pine from the Black Hills, provided background for this research (Barger 1967, Mueller et al. 1968, U. S. Forest Service 1956). These studies demonstrated the technical feasibility of producing plywood from this species, but the amount of timber tested was too limited to predict with confidence the amounts and kinds of veneer that could be produced from the Black Hills ponderosa pine resource as a whole.

This study was therefore designed primarily to obtain detailed veneer recovery data—by volume, grade and size—for a larger sample of typical Black Hills ponderosa pine, and then to expand the results for the sample to characterize the resource as a whole. A second objective was to provide veneer recovery and tree and log quality data for use in evaluating log and tree grades for Black Hills ponderosa pine.

METHODS

Sample Tree Selection

A sample of 144 trees was selected for this study from eight widespread locations in the Black Hills National Forest (fig. 1). Selections were made from stands identified by National Forest personnel as typical of sawtimber that will be available for harvest during the next 10 to 20 years. Once these areas were designated, trees were sampled in six diameter-breast-high (d.b.h.) classes by a systematic method described later.

This sampling plan was designed to meet two major conditions. First, trees included in the sample would be similar to, and cover the range of, sawtimber potentially available for veneer production. Second, the sample would be small enough to meet the limitations of logging the sample trees and hauling them nearly 800 miles to a plywood plant. While the resulting sample was smaller and less representative in a statistical sense than desired, it goes considerably beyond previous samples and, in our judgment, provides a reasonable basis for estimating veneer recovery from Black Hills ponderosa pine.

Previous research and experience indicated that tree size and knot characteristics of Black Hills ponderosa pine would limit high-volume veneer recovery from this resource to C and lower grades. It was also assumed, as Barger (1967) had found for southwestern ponderosa pine, that only the lower 16 feet of the tree stems would yield sufficient C grade veneer for production of 3/8-inch C-D grade plywood; above this height the proportion of C and better grades of veneer recovered would be insufficient to produce the required C grade face plies.

Accordingly, the sample was selected from trees that could be expected to yield economical quantities of at least D grade veneer with a sufficient proportion of C and better grades. These trees were termed "high-yield" and met the following defect criteria, as judged by visual inspection:

1. No dead knot greater than 4 inches in horizontal diameter.
2. No crook greater than one-third the top diameter of the 8-foot section containing it.
3. No fire scars.
4. No lightning scars (regardless of height in tree).
5. No butt rot.
6. Bottom two veneer blocks must be "chuckable."2/

2/ Blocks were considered chuckable if the wood was at least 50 percent sound in the area where the lathe chucks would strike the block. This was determined after the tree was felled.

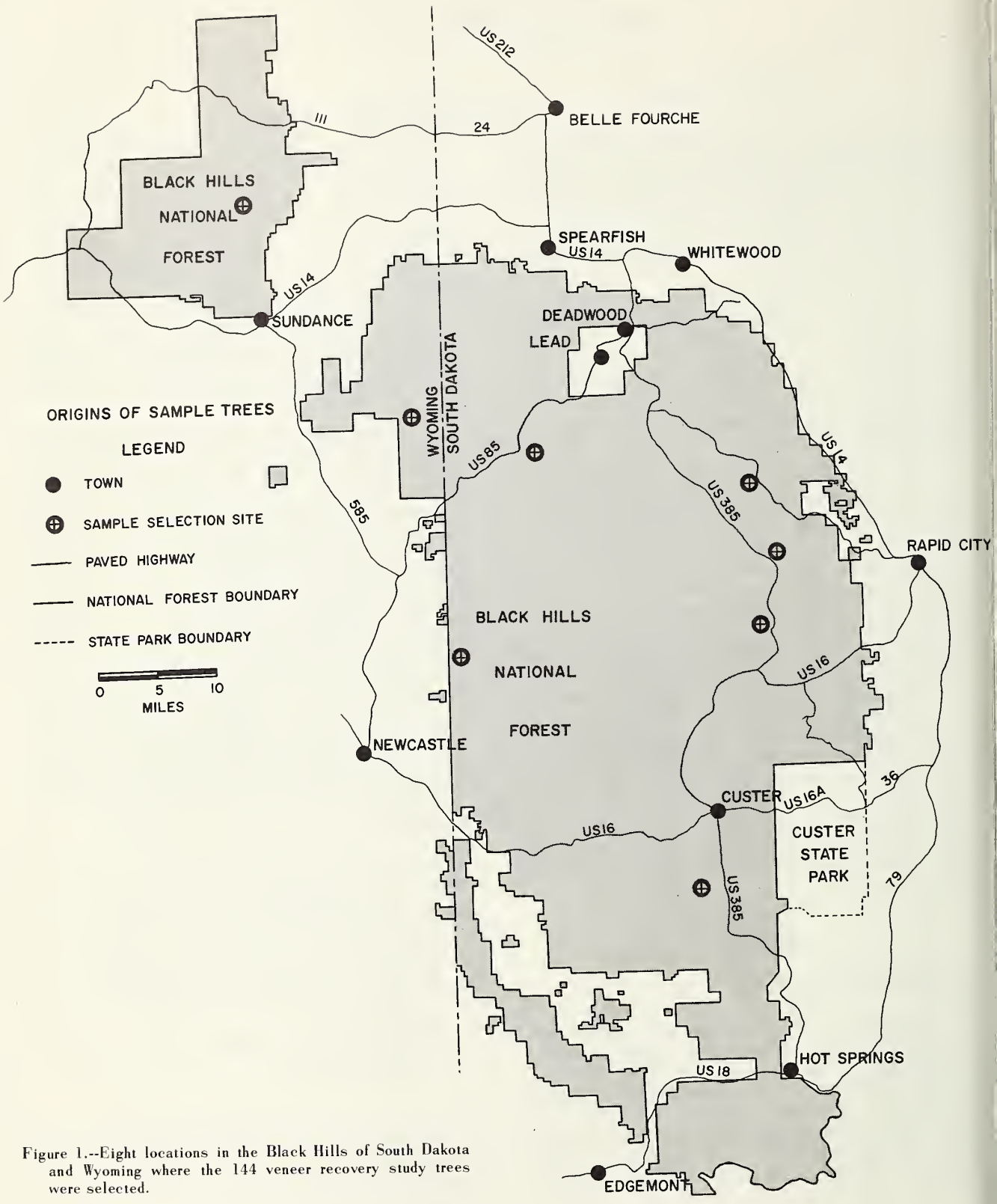


Figure 1.--Eight locations in the Black Hills of South Dakota and Wyoming where the 144 veneer recovery study trees were selected.

With the exception of lightning scars, these standards were applied to the bottom 16 feet of the tree stem (Ffolliott and Barger 1965). 3/ The presence of lightning scar anywhere in the merchantable stem of a tree was cause for rejecting that tree from the sample.

These defect criteria were based on published grade requirements for D grade veneer (American Plywood Association 1966), and estimates of potential veneer volume and grade recovery expected from blocks with various defects.

The d.b.h. classes included in the sample and the proportions of the total resource volume 4/ represented by each class are tabulated below. Note that approximately equal proportions of the volume are in each d.b.h. class.

D.b.h. class (Inches)	Diameter class range (Inches)	Percent of resource volume (Scribner bd. ft.)
10	10.0 - 10.9	19
12	11.0 - 12.9	21
14	13.0 - 14.9	18
16	15.0 - 16.9	17
18	17.0 - 18.9	12
19+	19.0 +	13

The sample included 24 trees in each of the d.b.h. classes, three from each of the eight sampling locations. Eighteen trees from each location (three from each d.b.h. class) were selected as encountered along a compass line run at right angles to the contours of the local topography. Trees within 1 chain of the compass line were selected if they met the diameter and defect criteria set for this study.

The bottom 32 feet of the stem of each sample tree was diagramed to show knot and defect size, type, and location. The trees were cruise graded by the 5-grade ponderosa pine log grading system (Gaines 1964). Each felled tree was bucked into logs from 8.5 to 35 feet long (8.5-foot multiples plus trim) and then scaled by the National Forest check scaler according to the U. S. Forest Service Scaling Handbook (1964).

After proper tagging and identification, the logs were yarded, loaded, and trucked to the Montezuma Plywood Company plant at Dolores, Colorado, for peeling into veneer.

3/ Subsequent work indicates that nearly 80 percent of the standing Black Hills ponderosa pine sawtimber trees meet these appearance standards.

4/ As reported in the 1963-73 Timber Management Plan for the Black Hills Working Circle, Black Hills National Forest.

Production Facilities

The Montezuma Plywood Company produces primarily softwood sheathing plywood from Engelmann spruce (Picea engelmannii) and ponderosa pine. The mill equipment and operating methods of this plant are considered representative of the type of facility that might be suitable for plywood production in the Black Hills. Basic green-end mill equipment includes a ring debarker, steaming chambers, an 8-foot lathe, and a six-deck tray system with two clippers. The dry-end and panel-layup equipment includes two natural gas jet dryers, patching equipment, two glue spreaders, and a 30-opening hot press. Panel-sizing equipment and one sanding unit complete the basic mill equipment.

Veneer Production

The woods-length logs were debarked, bucked into 102-inch veneer blocks, and steamed for 24 hours. Each block was measured for cubic volume calculations, scaled in board feet (Scribner scale), and identified as class I or II. Following are the knot sizes used to classify the blocks:

	Class I	Class II
Maximum size of—		
Live knots	2 inches	No limit
Dead knots	2 inches	4 inches

Class I blocks were expected to produce predominantly C and better (C+) grades of veneer, while class II blocks were expected to produce predominantly D grade veneer.

Normal plant veneer production techniques were followed. Only occasional slowdowns at the lathe were needed to meet study requirements. The veneer blocks were peeled into 1/10-inch veneer to a 5¼-inch core. Veneer was clipped as in normal plant production and separated into four size groups for drying—full width, half width, random width, and "fishtails" (tapered veneer sheets developed in block roundup that yield 4-foot veneer). The veneer was dried for 7 minutes in a jet dryer which had an input-end temperature of 390° F. and an output-end temperature of 410° F. Grading of the dry veneer was supervised by a DFPA Quality Supervisor. All veneer was sorted and tallied in seven grades—A, A patch (Ap), B, B patch (Bp), C, D, and E. A, B, C, and D grades were as described in U. S. Product

Standard PS 1-66 (American Plywood Association 1966). Ap veneer could contain up to 14 patchable defects in a 4- by 8-foot sheet. Bp veneer could contain up to 20 patchable defects in a 4- by 8-foot sheet. E veneer is grade D veneer with admissible rot.

Veneer recovery study methods and a color-coding system (fig. 2) developed by the Timber Quality project of the Pacific Northwest Forest and Range Experiment Station were used (Lane 1971). These permit identification of veneer by individual veneer block, woods-length log, and tree from which it came.

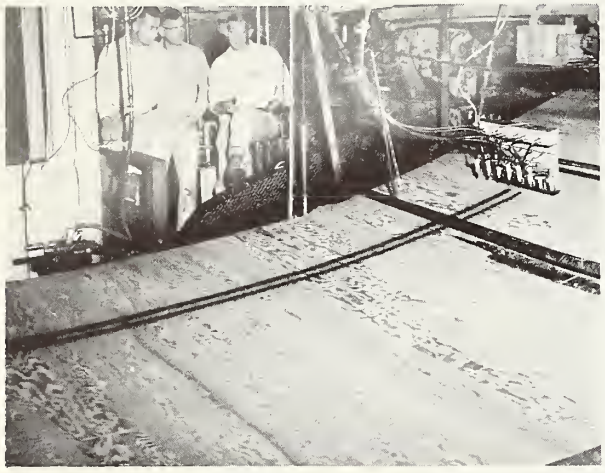


Figure 2.--Color coding veneer with a dye spraying unit for identification.

Statistical Methods

Data from this study were compiled and processed by means of two ADP programs specifically developed for veneer recovery data (Woodfin and Mei 1967). Outputs from these two programs provide veneer grade yield volumes and values on log input units ranging from the individual peeler block to the complete tree. These data were grouped by tree d.b.h. classes, position of the peeler block in the tree, block diameter, and block class (reflecting knot size). The veneer recovery data, summarized by these variables, were then subjected to regression analysis using the polynomial regression program (POLY) developed by the Biometrics Staff of the Pacific Northwest Forest and Range Experiment Station in 1968. This program calculates first, second, and third degree regression equations. Ninety-five percent level of significance has been used throughout this report.

RESULTS AND DISCUSSION

Sample Trees

Trees for this study were selected from six d.b.h. classes and were required to meet given defect criteria. The sample included both "blackjack" and "yellowbark" 5/ trees in all diameter classes without regard to tree heights:

D.b.h. class (Inches)	Blackjack trees (Number)	Yellowbark trees (Number)
10	22	2
12	21	3
14	14	10
16	7	17
18	2	22
19+	1	23
Total	67	77

Many of the sample trees had numerous limbs lower than 8 feet from the ground. In fact, persistent dead limbs extending nearly to the ground were not uncommon in blackjack trees of all diameters. Figures 3 and 4 show examples of trees and logs used in the study.

Tables 9 and 10 (see appendix) describe the sample trees by d.b.h. class and block position.

Figure 3.--Black Hills ponderosa pine trees. Trees numbered and banded were selected for the veneer recovery study. Bands are about 4 feet aboveground.

A. Size and quality of study trees ranged from small blackjack to large yellowbark trees.

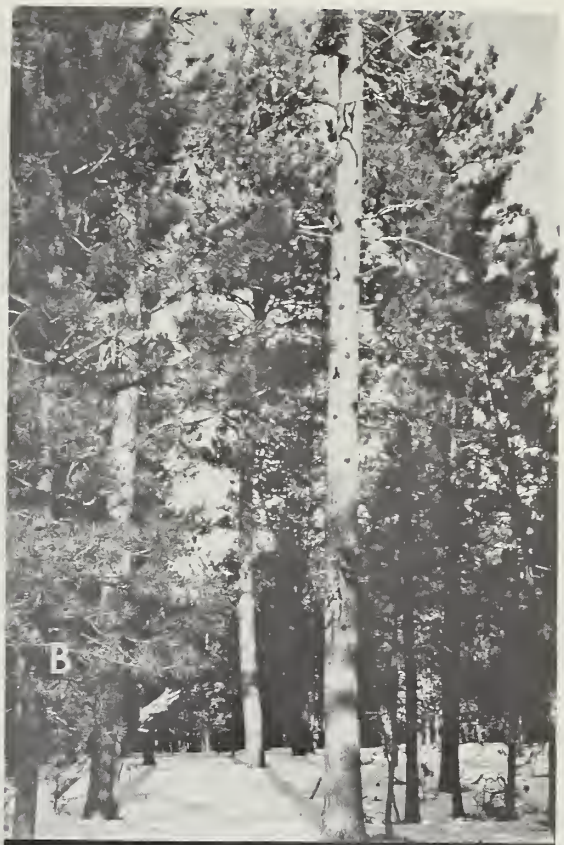
B. Note limbiness about half way up large yellowbark tree; this causes lower yields of C+ veneer in higher block positions.

C. Note numerous limbs extending nearly to the ground on large blackjack tree.

D. Small yellowbark tree shows an acceptable degree of sweep. (The 8-foot range pole has 1-foot graduations.)

5/ Blackjack trees are those with dark gray to black bark. This bark color usually indicates a vigorously growing tree under 100 years of age. Yellowbark trees are those with orange-colored bark, which usually indicates a slow-growing tree over 100 years old.


A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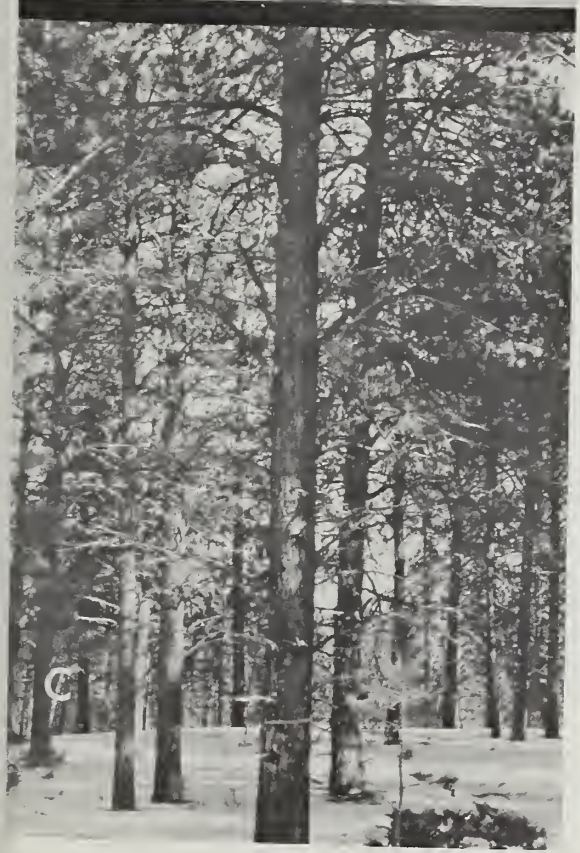
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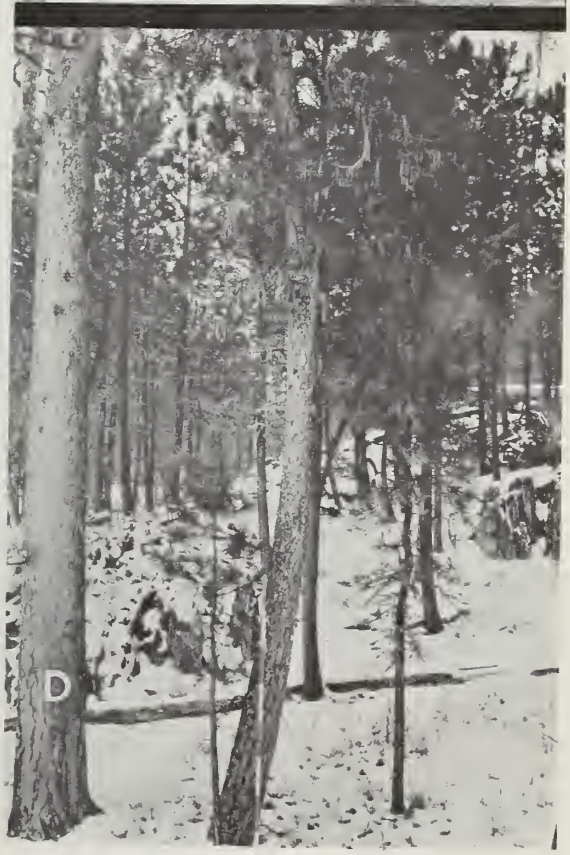
D

Figure 4.--Deck of Black Hills ponderosa pine logs used in the veneer recovery study. Note range in diameters and numerous knots.

The 144 sample trees were bucked into 236 woods-length logs, which were in turn bucked into 712 8-foot veneer blocks. The gross Scribner scale volume of the woods-length logs was 27,460 board feet; the net scale was 26,450 board feet, giving a defect factor of 4 percent. The 8-foot blocks scaled a gross volume of 27,980 board feet, Scribner scale, and a net volume of 25,320 board feet, giving a defect factor of about 10 percent. Approximately 49 percent of the trees contained some red and/or brown rot. Average scaled volumes and percentage of defects for trees in each of the six d.b.h. classes are shown in table 1. Utilized height of the trees in each d.b.h. class varied, (table 2).

Application of Results

The sampling procedure used resulted in an equal number of trees in each of the six d.b.h. classes. As a consequence, the larger d.b.h. classes in the sample had considerably greater volumes than the smaller classes. This distribution of volume among the d.b.h. classes was considerably different from that for the resource as a whole. Therefore, in applying these recovery data to the entire resource, the study data for each d.b.h. class must be weighted by the proportion of the total resource volume in that d.b.h. class.

Veneer Blocks

A quality classification was assigned to each of the 712 veneer blocks cut from the sample trees; 272 were identified as class I (blocks with knots under 2 inches) and the remaining 440 as class II. Class I blocks came primarily from smaller trees and lower stem positions (see appendix, table 10). Red rot (Polyporus anceps Pk.) and/or brown rot (not identified) in incipient and advanced stages were detected in 235 blocks from 70 trees.

Table 1.--Average scaled volumes of sample trees by d.b.h. classes

D.b.h. class (Inches)	Diameter class range	Average scaled volume/tree (Scribner scale)		Defect
		Gross	Net	
	Inches	Board feet		Percent
10	10.0-10.9	43.8	43.8	0
12	11.0-12.9	70.8	66.7	6
14	13.2-14.9	125.0	120.8	3
16	15.1-16.9	199.2	190.4	4
18	17.2-18.8	275.0	267.1	5
19+	19.0-24.3	430.4	414.2	4

Table 2.--Average top diameters and range in utilized heights of sample trees by d.b.h. classes

D.b.h. class (Inches)	Average top diameter	Utilized height			
		Maximum		Minimum	
	Inches	Feet	Number of blocks	Feet	Number of blocks
10	7.4	35.0	4	17.2	2
12	7.5	43.7	5	17.3	2
14	8.0	61.2	7	26.2	3
16	8.7	69.9	8	26.3	3
18	8.6	70.1	8	34.8	4
19+	9.8	79.4	9	43.6	5

Seventy-eight of the blocks were, for various reasons, either not peeled down to the intended core diameter (5¼-inch) or not peeled at all. Fifty-three blocks spun out of the chucks, and seven broke in the lathe before the desired core diameter was reached. Sixteen were dropped before peeling due to roughness or flexing. Two had diameters too small for the lathe charger to handle and could not be peeled.

Table 3 summarizes block volumes and diameters. The average block diameter of this sample was 11.4 inches, slightly larger (0.2 inch and 0.5 inch, respectively) than the average log diameters reported for two previous random samples of Black Hills ponderosa pine saw logs (Landt and Woodfin 1959, Yerkes 1966).

Veneer Recovery

The 80,577 square feet (3/8-inch basis) of dry untrimmed veneer produced in the study was sufficient in grades and sizes to produce C-D grade plywood panels (fig. 5). Forty-seven percent of this veneer was in C+ grades.

Table 3.--Veneer block scale volume and defect by block diameter class

Block diameter class	Number of blocks	Block volume (Scribner scale)		Defect
		Gross	Net	
Inches		Board feet		Percent
6	4	0	0	0
7	47	470	430	9
8	98	980	930	5
9	81	1,620	1,490	8
10	88	2,640	2,300	13
11	76	2,280	2,060	10
12	74	2,960	2,740	7
13	60	3,000	2,790	7
14	60	3,600	3,270	9
15	46	3,220	2,790	13
16	36	2,880	2,530	12
17	23	2,070	1,930	7
18	10	1,100	990	10
19	5	600	560	7
20	4	560	510	9
Total	712	27,980	25,320	1/ 10

1/ Total defect as a percent of total gross scale.

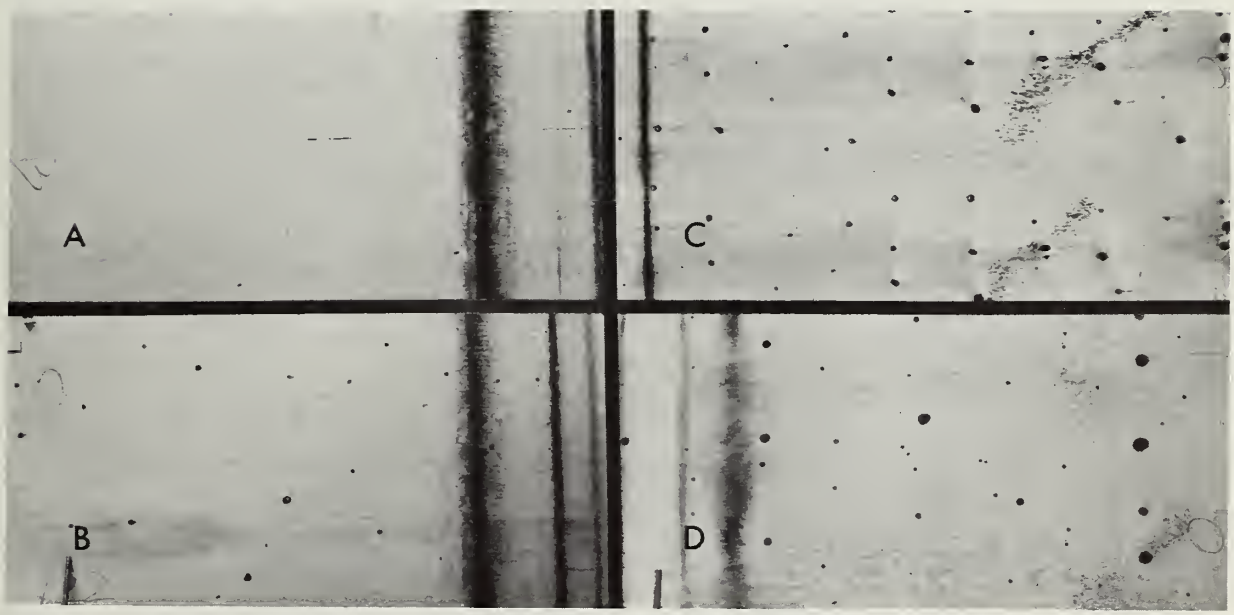

Figure 5.--Examples of 1/2-inch plywood panels fabricated from Black Hills ponderosa pine veneer.
A. Grade B face.
B. Grade C face (high C).
C. Grade D face (high D or low C).
D. Grade D face.

The ratio of dry untrimmed veneer output (3/8-inch basis) to log-volume input was 3.02 on a net woods-log scale [6/] and 3.18 on a net block scale.

The percent of C+ veneer recovered from blackjack and yellowbark trees did not differ significantly (95 percent level).

Veneer grades.—Some veneer was recovered in all seven dry-veneer grades (table 4), but only negligible amounts were recovered in grades above C.

Figures 6, 7, and 8 present scatter diagrams, regression lines, and confidence intervals for the whole line for the percentage of C+ veneer recovered as related to tree d.b.h., block position, and block diameter, respectively. These regression lines are statistically significant even though the data points vary widely. The implications are that the average recovery of C+ veneer will tend to fall within the confidence intervals shown and that the trend of C+ recovery should follow the general slope of the regression.

There was a slight decrease in the proportion of veneer in C+ veneer grades from trees in larger d.b.h. classes. The regression curve indicates that blocks from positions 1 and 2 yielded over 50 percent C+ veneer, while blocks from the fourth position and above yielded between 20 and 33 percent C+ veneer. The percentage of C+ veneer recovered increased only slightly with block diameter.

The apparently conflicting trends of increase in C+ recovery with block diameter and decrease with tree size is a result of the greater number of large knots, both live and dead, in the middle stem positions of larger trees. The increasing number of knots is sufficient to reduce the proportion of C+ veneer in larger trees. Larger diameter blocks in lower stem positions rarely have the larger knots, so the proportion of C+ veneer recovered improves in both lower block positions in the tree and larger diameter blocks.

6/ Recovery ratio indicates the square feet of dry untrimmed veneer (3/8-inch basis) produced from each board foot (net Scribner scale) of logs or blocks.

Recovery ratio.—Computing veneer recovery ratios is the accepted means of estimating total veneer or plywood output for a given log volume input. Analysis of the recovery ratios (net log scale) by tree d.b.h. indicated an increasing recovery ratio with increasing d.b.h.:

Tree d.b.h. class (Inches)	Veneer recovery ratio		
	Maximum	Minimum	Average
10	2.80	0.33	1.36
12	3.63	0.60	2.07
14	3.35	1.37	2.74
16	4.25	1.83	3.01
18	4.78	2.17	3.26
19+	4.38	2.68	3.27

The 10-inch and 12-inch d.b.h. classes had ratios below 2.5, often considered to be a favorable recovery figure by the industry, while larger d.b.h. classes had ratios above this value.

When recovery ratios (net block scale) were analyzed by block position, the average recovery ratios tended to remain fairly constant

Table 4.--Percentage of total veneer recovered from tree d.b.h. classes in seven dry veneer grades

D.b.h. class (Inches)	Veneer volume (3/8-inch basis)	Veneer grade						
		A	Ap	B	Bp	C	D	E 1/
	Sq. ft.	Percent						
10	1,426	--	--	--	--	51.9	47.4	0.7
12	3,441	--	--	--	0.7	66.7	30.1	2.5
14	8,059	0.1	0.1	1.0	1.9	59.5	33.1	4.3
16	13,734	--	--	1.0	2.6	50.2	40.7	5.5
18	21,391	.6	.1	2.0	1.3	41.0	51.5	3.5
19+	32,526	--	--	.8	1.6	37.6	56.9	3.1
All trees	80,577	0.2	0.0	1.1	1.7	44.3	49.1	3.6

1/ E is grade D veneer with admissible rot.

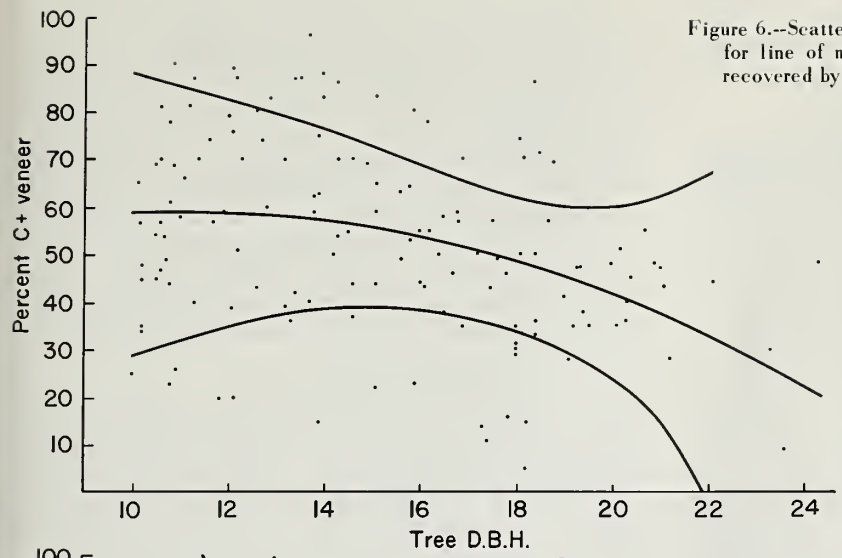

Figure 6.--Scatter diagram and confidence intervals (95 percent) for line of mean values (regression) for percent C+ veneer recovered by tree diameter.

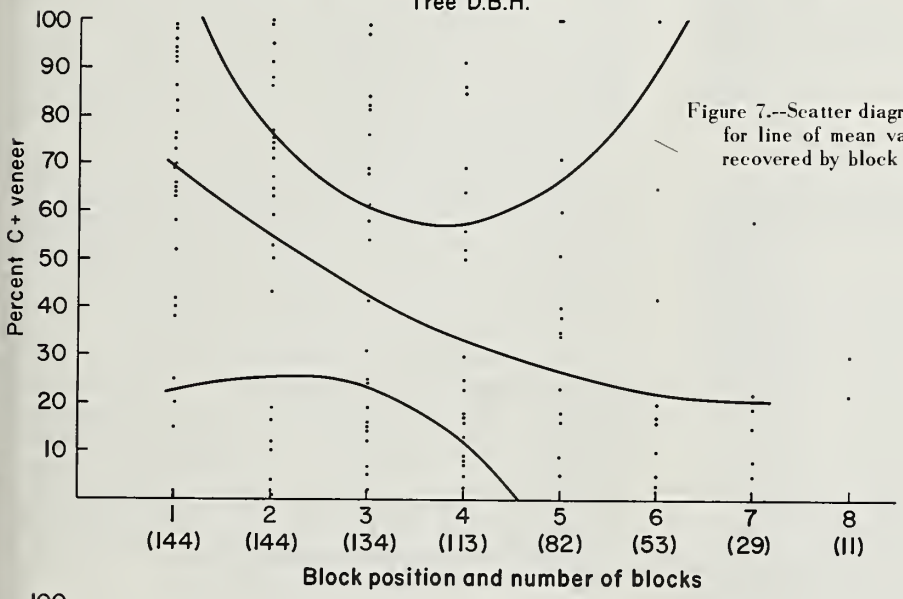

Figure 7.--Scatter diagram and confidence intervals (95 percent) for line of mean values (regression) for percent C+ veneer recovered by block position (plot of 20 percent of all points)

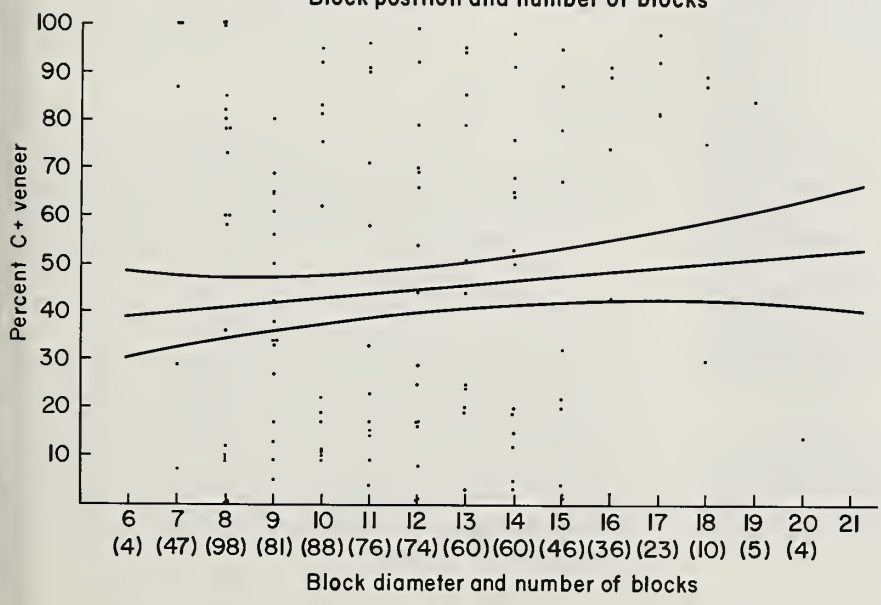

Figure 8.--Scatter diagram and confidence intervals (95 percent) for line of mean values (regression) for percent of C+ veneer recovered by block diameter class (plot of 20 percent of all points).

to the sixth block, then decreased with higher block positions:

Block position	Veneer recovery ratio		
	Maximum	Minimum	Average
1	6.00	0.00	3.22
2	7.00	.25	3.23
3	7.25	.00	3.16
4	7.75	.00	3.14
5	9.00	.00	3.22
6	7.00	.00	3.36
7	5.00	.25	2.77
8	4.50	.00	1.93
9	0.50	.00	0.10

No strong relationship was found between recovery ratios (net block scale) and block diameter. However, as shown below, average recovery ratios increased through the 11-inch blocks, leveled out between the 11- and 17-inch blocks, then declined slightly in the larger diameter blocks:

Block diameter class	Veneer recovery ratio		
	Maximum	Minimum	Average
6	7/ --	--	--
7	--	0.00	0.77
8	--	.00	1.80
9	--	.00	2.33
10	--	.00	2.49
11	--	.97	3.56
12	--	.75	3.36
13	7.85	1.08	3.41
14	--	1.95	3.42
15	--	1.89	3.63
16	6.90	2.23	3.53
17	5.74	1.77	3.48
18	4.53	2.51	3.16
19	3.52	2.52	3.01
20	3.46	1.84	2.98

Table 5 compares recovery ratios for sound and defective veneer blocks. Average recovery ratios for sound blocks increased rapidly from 0.77 for 6-inch blocks to about 3.20 for 12-inch blocks, only slightly to 3.36 for 17-inch blocks, then dropped to 2.65 for 20-inch blocks. This drop in recovery ratio for larger diameter blocks that are apparently sound may result from hidden defects. It could be anticipated that any inaccuracy in estimating defect would directly affect the recovery ratio, whether due to inaccurate scaling or to the inability of the scaler to see hidden defects. Recovery ratios for blocks scaled as defective (average 4.32) are therefore considerably higher than those for blocks scaled as sound (average 2.47). The lowest average recovery ratio for defective blocks was 2.99 in the 19-inch diameter class. Highest recovery ratios in these defective blocks were also reached in the middle diameter classes (11- to 13-inch classes), with lower ratios in both diameter extremes.

7/ No recovery ratios are shown for block diameter classes in which there were one or more blocks with zero scale volume. A zero volume in the denominator gives a mathematically infinite recovery ratio, which obviously is not meaningful.

Veneer sizes.—Veneer in this study was clipped and sorted into sheets of four size groups—8-foot lengths in full widths (54 inches), half widths (27 inches), and random widths, and 4-foot lengths in random widths. Fifty-two percent of the veneer recovered was full width, 7 percent was half width, and 31 percent was random width (table 6). Four-foot lengths in random widths accounted for the remaining 10 percent of the veneer.

Over half of the veneer recovered in the 14-inch and larger d.b.h. class was full width. Recovery in the 12-inch d.b.h. class was roughly equal between full width and random widths (including the 4-foot lengths), while the 10-inch d.b.h. class produced over 50 percent 8-foot random widths (see appendix, table 11).

The summary of veneer recovery in the four width and length classes by block position (table 7) shows that blocks from positions higher in the trees yielded lower percentages of 8-foot veneer in full widths. The opposite is true of 4-foot veneer in random widths. Percentages of both half widths and random widths in 8-foot lengths were nearly constant in all nine block positions (see appendix, table 12).

Block Classes

The potential of each block to produce predominantly C+ or predominantly D grade veneer was visually judged before the blocks were peeled. The purpose of this classification was to determine whether recovery could be predicted by a simple sorting system. Each block was assigned a designation of class I or class II, depending on maximum knot sizes. Class I blocks, expected to produce predominantly C+ veneer, were those with no knot greater than 2 inches in horizontal diameter. Blocks designated class II, expected to produce mostly D grade veneer, had dead knots between 2 and 4 inches in horizontal diameter and live knots over 2 inches.

Table 5.--Recovery ratios for 687 sound and defective blocks, by diameter class

Block diameter class (Inches)	Sound			Defective[1/]		
	Max.	Min.	Ave.	Max.	Min.	Ave.
6	--	--	--	--	--	--
7	6.00	0.0	0.77	--	--	--
8	5.90	.0	1.72	--	--	--
9	4.75	.0	2.14	6.70	1.20	3.39
10	3.77	.0	2.22	11.10	1.30	3.66
11	4.60	.97	3.17	12.80	2.80	5.40
12	4.80	.75	3.20	5.20	1.67	3.89
13	4.06	1.08	3.12	7.85	3.07	4.62
14	4.17	1.95	3.13	10.60	2.28	4.27
15	4.29	1.89	3.10	5.47	3.38	4.20
16	4.34	2.57	3.22	6.90	2.23	3.93
17	3.80	2.90	3.36	5.74	1.77	3.69
18	3.45	2.69	2.94	4.53	2.51	3.33
19	3.52	2.52	3.02	3.78	2.64	2.99
20	3.46	1.84	2.65	3.53	3.26	3.38

1/ Cull blocks not included since a recovery ratio of infinity results if any amount of veneer is realized from a block with zero scale.

Table 6.--Percentage of veneer recovered within each tree d.b.h. class by width and length

D.b.h. class (Inches)	Veneer volume (3/8-inch basis)	8-foot lengths			4-foot lengths
		Full width	Half width	Random width	Random width
	Sq. ft.	- - - - Percent - - - -			
10	1,426	21	6	52	17
12	3,441	43	9	36	12
14	8,059	51	8	30	11
16	13,734	56	7	27	10
18	21,391	56	7	28	9
19+	32,526	52	6	33	9
All classes	80,577	52	7	31	10

Table 7.--Percentage of veneer recovered in block positions by width and length

Block position	Veneer volume (3/8-inch basis)	8-foot lengths			4-foot lengths
		Full width	Half width	Random width	Random width
	Sq. ft.	- - - - Percent - - - -			
1	22,316	50	8	33	9
2	18,991	61	7	25	7
3	15,185	56	6	29	9
4	11,200	50	7	32	11
5	7,020	47	5	36	12
6	3,965	38	8	40	14
7	1,549	25	7	48	20
8	347	19	11	46	24
9	4	0	0	100	0
Total	80,577	52	7	31	10

The 273 class I blocks produced 63.2 percent C+ veneer, while the 439 class II blocks produced 32.3 percent C+ veneer. When the recovery of C+ veneer from class I and II blocks was analyzed separately, neither class had regression curves that were statistically significant. However, the difference between the means of the two classes was significant (see appendix, tables 13 and 14).

Cubic-Foot Volume

The study trees contained 5,378 cubic feet of merchantable wood—the sum of veneer block cubic volumes as calculated by Smalian's formula. Of this volume, 2,413 cubic feet, or 45 percent, was recovered as dry untrimmed veneer:

D.b.h. class (Inches)	Average tree volume to utilized top (Cu. ft.)	Proportion recovered as veneer (Percent)
10	10.45	17.0
12	15.95	26.8
14	26.95	37.2
16	38.68	44.3
18	54.26	49.2
19+	77.76	52.2
Total		44.9

The remaining 55 percent was residue in the form of cores, roundup waste, and green veneer clippings. Larger d.b.h. classes yield

a higher percentage of their cubic-foot volume as veneer. This is due primarily to the nearly constant volume of individual cores, regardless of tree or block diameters.

Table 8 summarizes the distribution of total cubic-foot volume among veneer recovered, cores, and roundup and clipper losses for veneer blocks. Table 15 (see appendix) breaks down the cubic-foot volume into various products and residues by tree d.b.h. class.

Core Use

The 712 veneer blocks produced 683 cores that were sawn into 2- by 4-inch by 8-foot studs; 1,650 studs were produced from these cores with an average of 2.4 studs per core. Of the remaining 29 cores, 21 contained unacceptable rot or were otherwise unsuited for studs, and 8 were withdrawn for use in preservative treating tests.

CONCLUSIONS

1. A sample of 144 Black Hills ponderosa pine trees from six d.b.h. classes, meeting defect criteria of the study, yielded veneer in a proportion of grades and sizes that was more than adequate to produce C-D grade 3/8-inch 3-ply plywood.

2. Trees in larger d.b.h. classes yielded a higher percentage of veneer but lower percentages of C+ grades than trees in smaller d.b.h. classes.

3. Larger diameter veneer blocks yielded slightly higher percentages of C+ grades than smaller diameter blocks.

4. Blocks in lower tree positions yielded larger proportions of C+ grades of veneer than blocks in higher tree positons.

5. Recovery ratios appeared favorable for conversion of trees to plywood except for trees and blocks of small diameters.

6. More than enough full width sheets of C+ and D grades of veneer were recovered to provide one-piece face plies, even if all plywood that could have been produced in this study were 3/8-inch 3-ply panels.

7. Knot size, as estimated on the veneer blocks, was a useful means of separating the blocks into two classes yielding significantly different proportions of C+ veneer.

8. Recovery data varied widely with all classes of trees and blocks; however, it is believed that any large sample of Black Hills trees in these diameters would give nearly the same veneer recovery as those in this study.

Table 8.--Summary of average cubic foot volume[1/] of veneer blocks by diameter class

Block diameter class	Total	Veneer		Core		Roundup and clipper losses	
Inches	Cu. ft.	Cu. ft.	Pct.	Cu. ft.	Pct.	Cu. ft.	Pct.
6	2.89	0.17	6	1.86	64	0.86	30
7	2.85	.21	7	2.08	73	.56	20
8	3.73	.51	14	2.00	54	1.22	32
9	4.61	1.28	28	1.77	38	1.56	34
10	5.48	1.95	35	1.74	32	1.79	33
11	6.71	2.88	43	1.62	24	2.21	33
12	7.84	3.73	48	1.64	21	2.47	31
13	9.05	4.75	52	1.61	18	2.69	30
14	10.39	5.59	54	1.61	15	3.19	31
15	11.98	6.59	55	1.65	14	3.74	31
16	13.53	7.43	55	1.71	13	4.39	32
17	15.48	8.75	56	1.80	12	4.93	32
18	17.81	9.38	53	1.76	10	6.67	37
19	17.97	10.11	56	1.75	10	6.11	34
20	22.84	11.40	50	1.68	7	9.76	43

1/ Based on block volume computed by Smalian's formula.

SUMMARY

Some of the first and most important information needed to determine the economic feasibility of producing plywood from a timber resource not previously used for this purpose is the amount and grades of veneer that the resource will yield. This study developed such information for Black Hills ponderosa pine timber.

A sample of 144 trees in six diameter classes was selected and processed into veneer. The selected trees were considered to be similar to those which will be harvested as sawtimber in the next 20 years. Veneer from each of 712 blocks cut from the sample trees was identified, graded, and tallied separately. This approach allowed accounting for veneer from each tree and tree section throughout the process.

These Black Hills ponderosa pine trees produced more than sufficient grades and proportions of veneer to produce C-D plywood entirely in 3/8-inch thickness. The proportion of the total veneer recovered in C and better grades increased with block diameter but decreased with tree diameter and the height of the block in the tree. The ratio of dry untrimmed veneer to board feet of log input appeared favorable except for small-diameter trees and blocks. Sufficient full width (4-foot) veneer sheets were produced to provide face plies for all the 3/8-inch C-D sheets of plywood that could have been made from the study veneer.

Knot size was found to be a useful means of separating blocks into two classes. One class yielded a larger proportion of C+ veneer, while the other yielded a larger proportion of D veneer.

The volume of dry untrimmed veneer produced was about 45 percent of the cubic-foot volume of the sample trees.

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Table 9.--Characteristics of 144 trees selected for the veneer recovery study of Black Hills ponderosa pine

D.b.h. class (inches)	Trees	Total Blocks	Average d.b.h.	Average utilized height	Scribner scale --block[1/]		Scribner scale --woods log[2/]		Defect		Blocks[3/]		Sample volume in d.b.h. class, woods-log scale
					Gross	Net	Gross	Net	Block	Woods log	Class I	Class II	
	Number	Number	Inches	Feet	Board feet				Percent		Percent		Percent
10	24	70	10.5	25.5	890	860	1,050	1,050	3	0	60	40	3
12	24	88	11.9	32.0	1,640	1,530	1,700	1,600	7	6	45	55	6
14	24	114	14.0	42.0	2,980	2,860	3,000	2,940	4	2	41	59	11
16	24	129	16.0	46.7	4,800	4,180	4,780	4,570	13	4	38	62	17
18	24	149	18.0	53.2	7,000	6,520	6,600	6,290	7	5	30	70	25
19+	24	162	20.1	59.1	10,670	9,370	10,330	9,940	12	4	31	69	38
Total or average	144	712			27,980	25,320	27,460	26,450	10	4	38	62	100

1/ Eight-foot block scale completed after debarking but before peeling.

2/ Woods-log scale of 235 logs from 8 to 35 feet; 20-foot maximum scale completed in the woods at the time of felling and bucking.

3/ Based on classification of blocks after debarking and steaming but before peeling.

Table 10.--Summary of veneer block characteristics by position in the tree within tree d.b.h. classes for 144 Black Hills ponderosa pine veneer recovery study trees

Block position and d.b.h. class (inches)	Blocks	Average scaling diameter	Scribner scale[1/]		Defect	Blocks[2/]	
			Gross	Net		Class I	Class II
	Number	Inches	Board feet		Percent	Percent	
Position 1:							
10	24	8.6	390	370	5	67	33
12	24	9.7	620	580	6	71	29
14	24	11.6	850	840	1	79	21
16	24	13.6	1,330	1,230	8	83	17
18	24	15.2	1,730	1,640	5	75	25
19+	24	17.8	2,460	2,260	8	83	17
Total or average	144		7,370	6,920	6	76	24
Position 2:							
10	24	8.1	280	280	0	62	38
12	24	9.0	490	460	6	42	58
14	24	10.6	760	730	4	42	58
16	24	12.8	1,150	1,050	9	62	38
18	24	14.5	1,560	1,460	6	54	46
19+	24	16.8	2,130	1,900	11	67	33
Total or average	144		6,370	5,880	8	55	45
Position 3:							
10	17	6.4	170	170	0	53	47
12	21	8.1	330	310	6	48	52
14	24	10.2	670	660	1	29	71
16	24	11.6	940	820	13	42	58
18	24	13.5	1,300	1,200	8	25	75
19+	24	15.8	1,880	1,650	12	29	71
Total or average	134		5,290	4,810	9	37	63
Position 4:							
10	5	7.0	50	40	20	40	60
12	15	7.5	160	150	6	20	80
14	22	9.2	460	410	11	27	73
16	23	10.7	720	630	12	9	91
18	24	12.4	1,060	1,010	5	17	83
19+	24	14.4	1,610	1,330	17	17	83
Total or average	113		4,060	3,570	12	19	81
Position 5:							
10	--	--	--	--	--	--	--
12	4	7.3	40	30	25	0	100
14	13	8.2	180	170	6	31	69
16	20	9.4	460	320	30	10	90
18	22	10.9	720	660	8	9	91
19+	23	13.2	1,180	1,000	15	9	91
Total or average	82		2,580	2,180	16	12	88

Table 10.--Summary of veneer block characteristics by position in the tree within tree d.b.h. classes for 144 Black Hills ponderosa pine veneer recovery study trees--Continued

Block position and d.b.h. class (inches)	Blocks	Average scaling diameter	Scribner scale[1/]		Defect	Blocks[2/]	
			Gross	Net		Class I	Class II
	Number	Inches	Board feet		Percent	Percent	
Position 6:							
10	--	--	--	--	--	--	--
12	--	--	--	--	--	--	--
14	5	7.8	50	40	20	0	100
16	10	8.4	150	80	47	0	100
18	18	9.8	430	360	16	6	94
19+	20	12.0	810	700	14	5	95
Total or average	53		1,440	1,180	18	4	96
Position 7:							
10	--	--	--	--	--	--	--
12	--	--	--	--	--	--	--
14	2	7.1	10	10	0	50	50
16	3	7.7	40	40	0	0	100
18	10	8.7	170	160	6	0	100
19+	14	10.7	420	350	17	0	100
Total or average	29		640	560	12	3	97
Position 8:							
10	--	--	--	--	--	--	--
12	--	--	--	--	--	--	--
14	--	--	--	--	--	--	--
16	1	8.0	10	10	0	0	100
18	3	8.0	30	30	0	0	100
19+	7	9.4	150	140	7	0	100
Total or average	11		190	180	5	0	100
Position 9:							
10	--	--	--	--	--	--	--
12	--	--	--	--	--	--	--
14	--	--	--	--	--	--	--
16	--	--	--	--	--	--	--
18	--	--	--	--	--	--	--
19+	2	8.6	40	40	0	0	100
Total or average	2	8.6	40	40	0	0	100
All positions:							
10	70		890	860	3	60	40
12	88		1,640	1,530	7	45	55
14	114		2,980	2,860	4	41	59
16	129		4,800	4,180	13	38	62
18	149		7,000	6,520	7	30	70
19+	162		10,670	9,370	12	31	69
Total or average	712		27,980	25,320	10	38	62

1/ Eight-foot block scale completed after debarking but before peeling.

2/ Based on classification of blocks after debarking and steaming but before peeling.

Table 11.--Percent of veneer in various length and width classes by C+ and D grades within each tree d.b.h. class

D.b.h. class and grade	Veneer volume		8-foot lengths			4-foot lengths
			Full Width	Half Width	Random Width	Random Width
	Sq. ft.	Percent[1/]	- - - - - - Percent - - - - - -			
10 inches:						
C+	740	52.0	10.3	3.4	26.4	11.9
D	686	48.0	10.2	6.9	26.1	4.8
Total	1,426	100.0	20.5	10.3	52.5	16.7
12 inches:						
C+	2,320	67.4	30.7	4.4	23.5	8.8
D	1,121	32.6	12.1	4.4	12.6	3.5
Total	3,441	100.0	42.8	8.8	36.1	12.3
14 inches:						
C+	5,054	62.7	33.4	4.1	17.6	7.6
D	3,005	37.3	17.8	3.5	12.9	3.0
Total	8,059	100.0	51.2	7.6	30.6	10.6
16 inches:						
C+	7,384	53.8	29.5	3.9	13.8	6.5
D	6,350	46.2	26.7	2.8	13.6	3.1
Total	13,724	100.0	56.2	6.7	27.4	9.6
18 inches:						
C+	9,630	45.0	24.8	4.0	10.8	5.5
D	11,761	55.0	31.4	3.0	16.8	3.8
Total	21,391	100.0	56.2	7.0	27.6	9.3
19+ inches:						
C+	12,997	40.0	19.9	2.9	12.0	5.2
D	19,529	60.0	31.5	3.5	21.4	3.7
Total	32,526	100.0	51.4	6.4	33.4	8.9
All classes:						
C+	38,125	47.3	24.5	3.5	13.3	6.0
D	42,452	52.7	28.1	3.3	17.7	3.6
Total	80,577	100.0	52.6	6.9	31.0	9.6

1/ Rounding errors may cause some totals to be slightly different from the sum of the parts.

Table 12.--Percent of veneer in various length and width classes by C+ and D grades within each block position

Block position and grade	Veneer volume (3/8-inch basis)		8-foot lengths			4-foot lengths
			Full Width	Half Width	Random Width	Random Width
	Sq. ft.	Percent[1/]	- - - - - - - Percent - - - - - - -			
Position 1:						
C+	15,673	70.2	33.6	5.7	23.2	7.7
D	6,643	29.8	16.8	2.0	9.6	1.5
Total	22,316	100.0	50.4	7.7	32.8	9.2
Position 2:						
C+	11,198	59.0	38.2	4.2	11.8	4.7
D	7,793	41.0	23.1	2.4	13.4	2.2
Total	18,991	100.0	61.3	6.6	25.2	6.9
Position 3:						
C+	5,632	37.1	19.6	2.4	9.9	5.2
D	9,553	62.9	36.7	3.6	18.8	3.8
Total	15,185	100.0	56.3	6.0	28.7	9.0
Position 4:						
C+	3,257	29.1	12.4	1.9	8.4	6.4
D	7,943	70.9	37.8	5.4	23.3	4.4
Total	11,200	100.0	50.2	7.3	31.7	10.8
Position 5:						
C+	1,219	17.4	4.8	1.4	6.6	4.7
D	5,801	82.6	42.3	4.0	29.1	7.1
Total	7,020	100.0	47.1	5.4	35.7	11.8
Position 6:						
C+	751	18.9	5.3	1.4	6.1	6.1
D	3,214	81.1	33.1	6.8	33.4	7.9
Total	3,965	100.0	38.3	8.2	39.5	14.0

1/ Rounding errors may cause some totals to be slightly different from the sum of the parts.

(Continued)

Table 12.--Percent of veneer in various length and width classes by C+ and D grades within each block position--Continued

Block position and grade	Veneer volume (3/8-inch basis)		8-foot lengths			4-foot lengths
			Full Width	Half Width	Random Width	Random Width
	Sq. ft.	Percent	- - - - - - - Percent - - - - - - -			
Position 7:						
C+	303	19.6	1.9	1.3	9.1	7.2
D	1,246	80.4	23.1	5.6	38.9	13.0
Total	1,549	100.0	24.9	6.9	48.0	20.2
Position 8:						
C+	92	26.5	--	9.5	4.3	12.7
D	255	73.5	19.3	1.4	41.2	11.5
Total	347	100.0	19.3	11.0	45.5	24.2
Position 9:						
C+	--	--	--	--	--	--
D	4	100.0	--	--	100.0	--
Total	4	100.0	--	--	100.0	--
All positions:						
C+	38,125	47.3	24.5	3.5	13.3	6.0
D	42,452	52.7	28.1	3.3	17.7	3.6
Total	80,577	100.0	52.6	6.8	31.0	9.6

1/ Rounding errors may cause some totals to be slightly different from the sum of the parts.

Table 13.--Percent of veneer recovered in seven dry veneer grades by block class I and II and by block diameter

Block class and diameter (inches)	Number of Blocks	Veneer volume (3/8-inch basis)	Veneer grade							Grade Groups	
			A	Ap	B	Bp	C	D	E[1/]	C+	D
		Sq. ft.	- - - - - - - - - - - - Percent - - - - - - - - - - - -								
Class I:											
7	14	169	--	--	--	--	36.1	62.1	1.8	36.1	63.9
8	33	609	--	--	--	--	58.8	40.4	0.8	58.8	42.2
9	28	1,258	--	--	--	--	65.7	33.7	0.6	65.7	34.3
10	23	1,752	--	--	0.5	0.6	72.8	21.1	5.0	73.9	26.1
11	28	2,680	--	--	0.7	2.5	65.0	30.8	1.0	68.2	31.8
12	23	3,240	0.3	0.3	1.2	2.4	55.5	31.6	8.7	59.7	40.3
13	26	4,308	--	--	0.9	2.9	56.3	33.4	6.5	60.1	39.9
14	23	4,629	--	--	1.1	1.7	53.7	37.7	5.8	56.5	43.5
15	24	5,386	1.6	--	5.8	6.1	60.5	17.8	8.2	74.0	26.0
16	20	5,161	0.6	--	3.8	1.4	57.5	30.1	6.6	63.3	36.7
17	17	4,990	--	--	0.7	3.1	69.1	20.8	6.3	72.9	27.1
18	8	2,533	--	--	5.8	7.5	49.5	28.5	8.7	62.8	37.2
19	2	783	--	--	1.1	--	86.4	5.5	7.0	87.5	12.5
20	3	1,034	--	--	0.9	2.3	56.3	33.0	7.5	59.5	40.5
All class I	272	38,532	0.3	(2/)	2.2	2.9	60.1	28.2	6.3	65.5	34.5
Class II:											
6	4	23	--	--	--	--	39.1	60.9	--	39.1	60.9
7	33	163	--	--	--	--	38.7	58.2	3.1	38.7	61.3
8	65	1,062	--	--	--	--	39.5	58.5	2.0	39.5	60.5
9	53	2,210	--	--	0.9	0.9	37.9	59.1	1.2	39.7	60.3
10	65	3,986	--	--	0.4	0.2	36.7	62.6	0.1	37.3	62.7
11	48	4,645	--	--	--	0.2	35.2	62.3	2.3	35.4	65.6
12	51	5,979	0.1	--	--	0.3	28.2	68.9	2.5	28.6	71.4
13	34	5,211	--	--	--	0.1	24.9	75.0	--	25.0	75.0
14	37	6,561	--	--	--	0.4	25.0	74.2	0.4	25.4	74.6
15	22	4,742	--	0.6	0.1	1.0	17.9	80.0	0.4	19.6	80.4
16	16	3,761	--	--	0.1	1.6	26.1	70.7	1.5	27.8	72.2
17	6	1,721	--	--	--	1.1	35.3	58.5	5.1	36.4	63.6
18	2	594	--	--	--	--	82.0	16.3	1.7	82.0	18.0
19	3	902	--	--	--	--	56.3	43.4	0.3	56.3	43.7
20	1	485	--	--	--	--	13.6	85.8	0.6	13.6	86.4
All class II	440	42,045	(2/)	0.1	0.1	0.5	29.8	68.3	1.2	30.5	69.5
Classes I and II	712	80,577	0.2	(2/)	1.1	1.7	44.3	49.1	3.6	47.3	52.7

1/ E is grade D veneer with admissible rot.

2/ Less than 0.05 percent.

Table 14.--Percent of veneer in various length and width classes by C+ and D grades within each block class

Block class and grade	Veneer volume (3/8-inch basis)		8-foot lengths			4-foot lengths
			Full Width	Half Width	Random Width	Random Width
	Sq. ft.	Percent[1/]	- - - - - - - Percent - - - - - - -			
Class I:						
C+	25,287	65.6	36.7	5.1	17.7	6.1
D	13,245	34.4	21.3	2.2	9.4	1.5
Total	38,532	100.0	58.0	7.3	27.1	7.6
Class II:						
C+	12,838	30.5	13.2	2.1	9.2	6.0
D	29,207	69.5	34.3	4.4	25.4	5.4
Total	42,045	100.0	47.5	6.5	34.6	11.4
All classes:						
C+	38,125	47.3	24.5	3.5	13.3	6.0
D	42,452	52.7	28.1	3.3	17.7	3.6
Total	80,577	100.0	52.6	6.8	31.0	9.6

1/ Rounding errors may cause some totals to be slightly different from the sum of the parts.

Table 15.--Cubic foot volume summary by d.b.h. class

D.b.h. class (inches)	Volume					Veneer Recovery
	Average utilized tree volume	Total tree volume[1/]	Veneer	Core	Roundup and clipper loss	
	- - - - - - - - Cubic feet - - - - - - - -					Percent
10	10.45	250.88	42.54	127.26	81.08	17.0
12	15.95	382.79	102.64	165.66	114.49	26.8
14	26.95	646.90	240.93	196.31	209.66	37.2
16	38.68	928.35	411.01	222.20	295.14	44.3
18	54.26	1302.33	640.97	258.09	403.27	49.2
19+	77.76	1866.36	975.16	278.86	612.34	52.2
All classes		5377.61	2413.25	1248.38	1715.98	44.9

1/ Based on block volume computed by Smalian's formula.

Yerkes, Vern P., and R. O. Woodfin, Jr.
1972. Veneer recovery from Black Hills ponderosa pine. USDA Forest Serv. Res. Pap. RM-82, 23 p. Rocky Mt. Forest and Range Exp. Sta., Fort Collins, Colo. 80521.

Veneer recovered from a selected sample of 144 Black Hills ponderosa pine sawtimber trees was sufficient in both volume and grades to allow production of at least 3/8-inch C-D plywood. Proportions of C and better grades of veneer increased with veneer block diameter but decreased with tree d.b.h. and block heights in the tree. This apparently conflicting trend results from the greater number of large knots in the middle-stem blocks of larger trees. Recovery ratios increased with both tree diameter and block diameter and were higher for defective blocks than sound blocks, due to the smaller net scale for defective blocks. Nearly 45 percent of the cubic-foot volume was utilized as veneer.

Key words: Pinus ponderosa, veneer, plywood.

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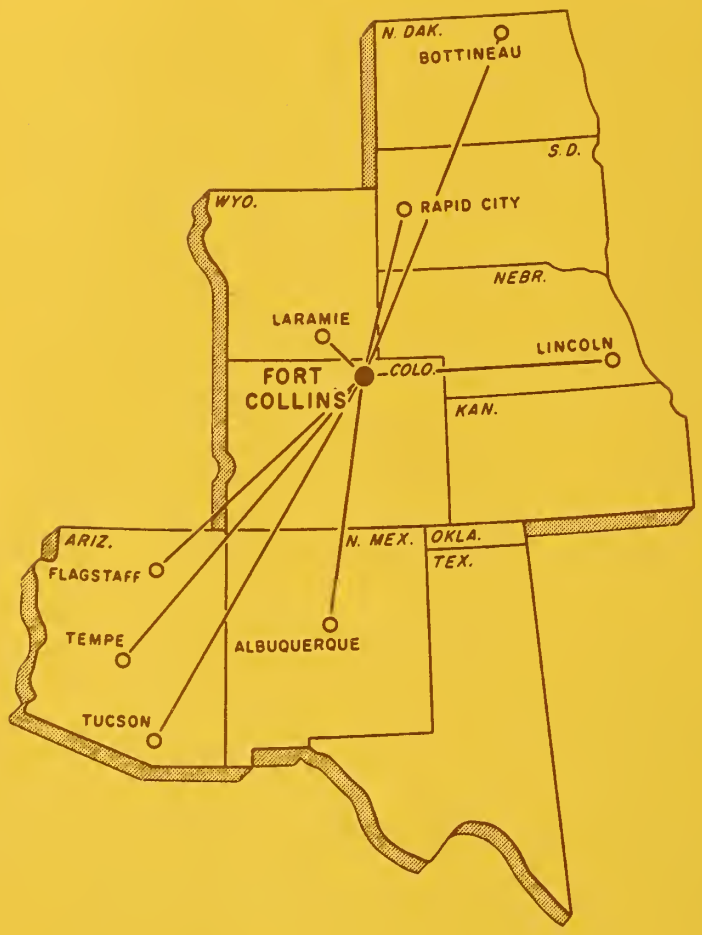
N. DAK.
BOTTINEAU
S.D.
WYO.
RAPID CITY
NEBR.
LARAMIE
LINCOLN
FORT COLLINS
COLO.
KAN.
ARIZ.
N. MEX.
OKLA.
TEX.
FLAGSTAFF
TEMPE
ALBUQUERQUE
TUCSON